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POLARIZED TARGETS AND POLARIZED LOW ENERGY NEUTRONS AT WNR *

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ABSTRACT

A description of the experimental setup used at the WNR facility to study the interaction of polarized neutrons with polarized samples is given. Planned measurements of the magnetic moments of compound nuclear resonances are discussed.

APPARATUS

The Weapons Neutron Research facility¹ (WNR) is a pulsed white-neutron source at the Los Alamos Scientific Laboratory. At WNR up to 1% (10 μ A) of the 800 MeV proton beam from the Los Alamos Meson Physics Facility is used to produce neutrons by spallation reactions on heavy metal targets. It is possible to optimize the proton width and target-moderator configuration to give a time-of-flight capability covering the neutron energy range from a few meV to several hundred MeV.

In Fig. 1 the present experimental arrangement is shown. An evacuated flight tube of 70-m length views a 15-cm-diameter area of the target and moderator. Several collimators confine the beam spot at 37 m to 2.5×2.5 cm², which is the maximum sample size. At 25 m a filter assembly is installed to prevent frame overlap. Two cryostats are located on the flight path at 35 m and 37 m from the neutron source. The first one contains a dynamically polarized proton sample $[\text{La}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}]$,

Fig. 1. Lay-out of the flight path for polarization experiments at WNR, 1 - target moderator and bulk shield, 2 - collimators, 3 - filter assembly, 4 - LMN cryostat, 5 - sample cryostat, 6 - detector station.

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3.2 x 3.2 x 1.8 cm³] from which the neutron beam emerges with a polarization of about 60% for energies up to 50 keV. In the second cryostat a ³He - ⁴He dilution refrigerator cools the sample under investigation to 20 mK. At that temperature, the nuclei are polarized with a magnetic field of 5.5 T. Reference 2 contains additional details about this apparatus.

EXPERIMENTS

As a first experiment we plan to exploit the intense neutron flux in the eV range at WNR in measurements of the magnetic moment of neutron resonances in ¹⁶¹Dy. Such measurements permit a determination of the average g-factor for these highly excited nuclear states which can be compared with calculations³ based on a thermodynamic description. Previously dysprosium resonances below 5 eV have been studied in Dubna⁴ with an unpolarized beam, but the errors do not exclude the value zero (within two standard deviations). This type of measurement has also been carried out at Brookhaven with an unpolarized target.⁵ Polarizing both the neutron beam and the target nuclei in the WNR setup provides the possibility of reducing systematic errors by switching the neutron polarization at intervals of about 15 minutes. The difference in resonance energy for the parallel and antiparallel orientation is expected to be about 10⁻⁵ eV if the magnetic moment changes by 1 n.m. between the target ground state and the resonance. It is possible to determine shifts in resonance energy at 3 eV to an accuracy of 2 x 10⁻⁶ eV with the expected timing precision of 1 ns.

In addition to the above measurement, we plan to investigate a variety of interactions of polarized neutrons with polarized nuclei. Some of the experiments would employ the "brute-force" method to polarize such targets as hydrogen and solid ³He to approximately 20%, enabling us to study the spin dependence of the total cross section and the scattering length.

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